(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 938 948 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
05.06.2002 Bulletin 2002/23

(51) Int Cl.[7]: **B24B 53/00**

(21) Application number: **99103712.8**

(22) Date of filing: **25.02.1999**

(54) Apparatus for profile mirror surface grinding

Vorrichtung zum Schleifen von Spiegeloberflächen

Appareil pour meulage de surface miroir

(84) Designated Contracting States:
CH DE FR GB LI NL SE

(30) Priority: **26.02.1998 JP 4543498**

(43) Date of publication of application:
01.09.1999 Bulletin 1999/35

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Description

BACKGROUND OF THE INVENTION

Technical Field of the Invention

[0001] The present invention relates to an apparatus for profile mirror surface grinding , as per the preamble of claim 1. An example of such an apparatus is disclosed by US 5 683 290 A.

Description of the Related Art

[0002] A stamping tool with complicated and high precision is essentially required for manufacturing some parts, for example a lead frame of a semiconductor in which an integrated circuit is installed, with similar complicated and high precision. Such stamping tool should be made by profile grinding of an ultra-hard material. Thus, profile grinding processes are required to carry out to make not only highly precise profiling, but also high efficient grinding for mirror to produce a high quality surfaca that determines a performance (sharpness, life, etc.) as a stamping tool. However, in conventional grinding art, it is difficult to realize both of shaping of high preciseness and mirror surface grinding of high quality simultaneously in high efficiency.

[0003] So far, a metal bond grindstone with high holding strength has been used for complicated profile grinding process. In such process, shaping can be done in high praciseness, although grinding cannot be done to produce high quality mirror. Therefore, profile grinding processes should be done separately each other. On the other hand, a thin, sharp grindstone to shape a stamping tool with a pattern of such narrow width as a lead frame should be shaped in consideration of change of preciseness caused by deforming of the grindstone. Therefore, the mechanical truing Is very difficult to apply.

[0004] In other words, the followings are problems in the background of separate processes of profile mirror surface grinding in conventional art: (1) the shape of a grindstone used for complicated profiling process does not allow shaping in high preciseness again alter wear-out, because the tip (processing part) of the grindstone is sharply pointed to be easily blunted by wear-out ; (2) reshaping after wear-out of the tip part does not maintain the sharpness of the grindstone in profiling process because difficulty of dressing of the grindstone.

[0005] On the other hand, electrolytic in-process dressing grinding method (hereafter, ELID grinding method) as a grinding means to realize high efficient, ultra-precise mirror surface grinding impossible by conventional shaping art has been developed and published by the present applicants. In the ELID grinding method, electrically conductive bonding part of a metal bond grindstone is dissolved by electrolytic dressing. An efficient mirror surface grinding for an ultra-hard material is possible by the grinding method using a metal bond grindstone containing fine grains. Particularly, it is very valuable that the ELID grinding process with dressing means for the metal bond grindstone allows high efficient and ultra-precise processing.

[0006] However, a thin grindstone having sharp-shaped tip is required for profiling process of the stamping tool particularly for such narrow width pattern as the lead frame. Therefore, although applying the ELID grinding method allows high efficient and ultra-precisely processed mirror, the following problem occurs: keeping the shape of tip is very difficult and high precise shaping is also difficult, because sharply pointed lip (processed part) of the grindstone is intensively subjected to electrolytic dressing. An apparatus for forming a convextip on a workpiece is known from US 5 683 290.

[0007] Therefore, it is desired to add shaping function of the metal bond grindstone to the ELID grinding process for reallzing both of high precise shaping and high quality grinding in high efficiency.

SUMMARY OF THE INVENTION

[0008] The present invention has been created to satisfy such request. The purpose of the invention is to provide an apparatus for profile mirror surface grinding allowing high efficient and simultaneous processing of high precise shaping and high quality mirror surlace grinding.

[0009] The present invention provides an apparatus for profile mirror surface grinding as per claim 1.

[0010] The present invention has achieved grinding processing of a complex and ultra-precise stamping tool used for manufacturing a lead frame for a semiconductor chip. It is because shaping of a grindstone allows reducing a load in shaping that may caused by a mechanical shaping. In addition it is because the metal bond grindstone containing fine grains is dressed by the ELID grinding method so as to allow simultaneous processing of profile mirror surface grinding effectively.

[0011] Further shaping and dressing of a grindstone can be separately and simultaneously carried out to allow high efficient setting and dressing of a grindstone with a given shape. On the other hand, sharpness of the grindstone is steady maintained by an effect of the ELID grinding and the shape of the grindstone can be maintained, if necessary, in operation of shaping of the grindstone; and therefore, it becomes possible to reduce steps of grinding for shaping and to shorten time for scheduling.

[0012] According to preferred embodiment of the present invention, the conductive grindstone (1) is consisted of grains made of diamonds or CBN and a conductive bonding part to fix the grains. This composition allows the spark truing and the ELID grinding to remove effectively the conductive bonding part, and shaping and dressing of the grindstone.

[0013] Besides, the semi-conductive part of disc-like electrode for shaping is preferably contains diamond

grains. By this constitution, the combination of sparktruing and diamond grains can be applied to grinding.

[0014] Other purposes and benefit characteristics of the present invention will be presented in the following description with reference to drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Fig. 1 is a front view of the apparatus for profile mirror surface grinding of the present invention.

[0016] Fig. 2 Is a diagrammatic view of the main part of the Fig. 1.

[0017] Fig. 3 is a fragmentary view taken in the direction of the arrows substantially along the line A-A.

[0018] Fig. 4 is an explanatory figure showing an embodiment of the present invention.

[0019] Fig. 5 is a test result of an embodiment of the present invention.

[0020] Fig. 6 is another explanatory figure showing an embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0021] Herewith, the preferred embodiment of the invention will be described with reference to the drawings. The same symbol is given to a common part in respective figures to omit a duplicate description.

[0022] Fig. 1 is a front view of the apparatus for profile mirror surface grinding. As shown in this figure, the apparatus for profile mirror surface grinding of the present invention has a voltage applying means 9 in which a conductive grindstone 1 is rotated around its axis and is used as a positive electrode, a dressing electrode 2 oppositely fixed to the surface of the grindstone without contact as a negative electrode, a disc-like shaping electrode 4 for shaping as a negative electrode, that is rotated around its axis separately from the conductive grindstone 1, and that is contacted to the surface of the conductive grindstone 1. a supplying means 10, 11, and 12 to supply an conductive grinding fluid in a space between the grindstone 1 and the dressing electrode 2 and the disc-like shaping electrode 4, a moving means 20 to move the disc-like shaping electrode 4 along with the surface of the conductive grindstone 1, and an actuating means 24 to relatively move the grindstone 1 to an object 22 to be processed.

[0023] Specifically, in the Fig. 1, a dressing electrode 2 is installed near an conductive grindstone 1 of the apparatus for profile mirror surface grinding in opposite aligning without contact. On the other hand, a disc-like shaping electrode 4 is installed In a stand 3 for installing an object for processing via a driving means 5. The disc-like shaping electrode 4 is rotated around its axis separately from the conductive grindstone 1. In addition, the dressing electrode 2 and the disc-like shaping electrode 4 are installed in the main body of the apparatus to have an insulate material 6 such as a plastic board between them in order to insulate electrically from the main body of the apparatus.

[0024] Fig. 2 is a diagrammatic view of the main part of the Fig. 1 and Fig. 3 is a fragmentary view taken in the direction of the arrows substantially along the line A-A. As shown In the Fig. 2 and Fig. 3, the object 22 to be processed and a thin board 22 for transcribing the shape of the conductive grindstone 1 are installed in the stand 3 for installing an object for processing. In addition, as shown in the Fig. 2, a voltage derived from an power source apparatus 9 as a voltage applying means is applied to make the conductive grindstone 1 as a positive electrode and the disc-like shaping electrode 4 and the dressing electrode 2 as negative electrodes. Furthermore, a supplying apparatus 10 supplying the conductive grinding fluid, nozzles 11 and 12, and a tubing system 11 a and 12a passing between them are installed for the conductive grinding fluid as a supplying means to supply the conductive grinding fluid to a space between the grindstone 1 and the dressing electrode 2 and a contact point of the grindstone 1 to the disc-like electrode 4 and a contact point of the grindstone 1 to the object for processing in order to supply the conductive grinding fluid through them.

[0025] On the other hand, a projector 8 has been installed In the top of the apparatus to display an image taken on a screen. Comparative position of the conductive grindstone 1, the object 22 to be processed, and the disc-like shaping electrode 4 are any time monitored by the projector 8. The shape of the grindstone 1 is known by contacting the grindstone 1 to the thin board 21 attached to the stand 3 for installing an object and by transcribing the shape of the grindstone 1 to the thin board 21, in addition to direct monitoring using the projector 8.

[0026] The present apparatus has an actuating means 24 such as X-Y table by NC capable of moving separately and simultaneously the grindstone 1 to the frontal and back direction 16 and left-hand and right-hand direction 17 of the Fig. 3 according to the designation of a control unit 7 to allow controlling freely the comparative position of the conductive grindstone 1, the object 22, and the disc-like shaping electrode 4 in two dimension.

[0027] According to the constitution of the apparatus for profile mirror surface grinding, as shown In the Fig. 3, the disc-like shaping electrode 4 is comparatively moved according to the surface of the grindstone 1 and the given shape of the grindstone by moving separately and simultaneously the conductive grindstone 1 to the frontal and back direction 16 and left-hand and right-hand direction 17 on the basis of contacting the grindstone 1 to the disc-like electrode 4, supplying the conductive grinding fluid to the contact point of the conductive grindstone 1 and the disc-like shaping electrode 4, and generating a spark. Therefore, the present shaping means of a grindstone can be operated independently and simultaneously with the dressing means of a grindstone by the ELID grinding method and the shaping of shape and dressing of a grindstone can be operated in

high efficiency.

[0028] A grindstone is dressed by using the apparatus for profile mirror surface grinding, applying a voltage between the conductive grindstone 1 and the shaping electrode 4, contacting the conductive grindslone 1 to the shaping electrode 4, shaping the conductive grindstone 1 by generating a spark on the contact point, and simultaneously, applying a voltage between the conductive grindstone 1 and the dressing electrode 2 opposite to the grindstone without contact, supplying the conductive grinding fluid between them, and subjecting the conductive grindstone to electrolytic dressing.

[0029] In other words, the conductive grindstone 1 is moved along with the desired shape of the object 22 to be processed, monitoring comparative position of the conductive grindstone 1 and the object to be processed by the projector B, by the actuating means 24 capable of moving separately and simultaneously the conductive grindstone 1 to the frontal and back direction 16 and left-hand and right-hand direction 17. The shaping means of the object to be processed can be operated simultaneously and separately from a means by the ELID grinding method, and is simultaneously applied to profiling process and mirror surface grinding of the object to be processed.

[0030] The conductive grindstone 1 can be subjected to profiling process to produce a desired shape in a high preciseness by contacting the conductive grindstone 1 to the shaping electrode 4 and generating a spark on the contact point to shape the conductive grindstone 1 (sparktruing). Further, according to aforementioned method, the conductive grindstone 1 can be dressed by the ELID grinding between the conductive grindstone 1 and the dressing electrode 2 opposite to the grindstone without contact, and high quality mirror surface grinding can be highly efficiently operated.

[0031] Besides, an apparatus for profile mirror surface grinding of the constitution can achieve grinding processing of a complex and ultra-precise stamping tool that is used for manufacturing a lead frame for a semiconductor chip. It is because shaping of a grindstone allows reducing a load In shaping that may caused by a mechanical shaping. In addition it is because the metal bond grindstone containing fine grains is dressed by the ELID grinding method so as to allow simultaneous processing of profile mirror surface grinding effectively.

[0032] Further shaping and dressing of a grindstone can be separately and simultaneously carried out to allow high efficient setting and dressing of a grindstone with a given shape. On the other hand, sharpness of the grindstone Is steady maintained by an effect of the ELID grinding and the shape of the grindstone can be maintained, if necessary, in operation of shaping of the grindstone; and therefore, it becomes possible to reduce steps of grinding for shaping and to shorten time for scheduling.

[0033] It is preferable that a conductive grindstone (1) is consisted of grains made of diamonds or CBN and a conductive bonding part to fix the grains. This composition allows the spark truing and the ELID grinding to remove effectively the conductive bonding part. and shaping and dressing of the grindstone.

[0034] The disc-like electrode 4 comprises a conductive part and a semi-conductive part. By this constitution, electric conductivity (electric resistance) of semi-conductive part can be set to a value appropriate to spark truing.

[0035] Besides, a semi-conductive part of disc-like shaping electrode 4 is preferably contains diamond grains. By this constitution, the combination of spark truing and diamond grains can be applied to grinding.

[0036] In the first place, spark truing tried by the means, that is shown in Fig. 4 (A), produced the same stock removal as that of depth of cut for very short time. In contrast, a conventional WA grindstone (so-called white alundum grindstone containing a main component of grains made of y aluminum oxide) as a Iruing grindstone produced almost no stock removal in comparison with that of depth of cut, Fig. 3 shows a relationship between depth of cut and reduction in radius. From these results, the conventional WA grindstone is difficult for mechanical truing of very hard grindstone such as metal bond grindstone made of cast iron used for the ELID grinding and inefficient.

[0037] Next spark truing of one-side V grindstone (conductive grindstone 1) was carried out by the means shown in Fig. 4 (B). The condition of spark truing was applied voltage 110 V, maximum current 10 A, pulse width in both ON and OFF 2 μsec. For optimal spark truing, a disc-like electrode (4) for shaping was composed of a conductive part and semi-conductive part and electric conductivity (electric resistance) of the semi-conductive part was adjusted to a value suitable for spark truing. As the result, the roughness of the grindstone before truing was about 100 μm in the standard surface and about 40 μm in inclined surface (15°), and after 3 hours, reduced to 5 μm.

[0038] A tapered part of the object for processing shown in Fig. 6 was ground by the ELID grinding using the one-side V grindstone (conductive grindstone 1) in combination of spark truing and measured the roughness of a surface, This object for procossing was ultra-hard alloy (V10 according to JIS), and the roughness of a surface before grinding was 1.31 μmRy. The condition of the ELID grinding was applied voltage 30 V, maximum current 2 A, pulse width in ON 2 μsec/OFF 4 μsec.

[0039] As the result, the roughness of a surface after finishing produced 0.069 μmRa and 0.24 μmRy very good surface quality was achieved in comparison With the conventional profile-grinding surface.

[0040] When the conductive grindstone was electrically, independently. and simultaneously dressed and shaped, shape and sharpness of the grindstone can be maintained in the high efficient shaping and grinding conditions, and also high efficient mirror and profiling process, that was so far difficult, of the object, such as

a punch for lead frame having a complex shape become possible. High precise profiling process has become possible, and as a result, the punch used for lead frame having high processing preciseness accomplishes high precise lead frame. In the case of the punch for lead frame, a surface subjected to mirror allows improving a performance (sharpness, life, etc.) than the past.

[0041] This means that a method and an apparatus for profile mirror surface grinding have an excellent effect capable of highly efficiently and simultaneously operate high precise profiling process and high quality mirror surface grinding.

[0042] Although the preferred embodiment of the invention has been described, the embodiment is to be considered In all respects as illustrative and not restrictive.

Claims

1. An apparatus for profile mirror surface grinding comprising:

   a voltage applying means (9) having an electrically conductive grindstone (1) rotated around its axis and used as a positive electrode, a dressing electrode (2) for dressing as a negative electrode that is oppositely fixed to the surface of the grindstone without contact, and a disc-like shaping tool (4) that is rotated around its axis and that is contacted to the surface of the grindstone,

   a supplying means (10, 11, 12) for supplying an electrically conductive grinding fluid in a space between the grindstone and the dressing electrode and the shaping tool,

   a moving means (20) for moving the disc-like shaping tool along with the surface of the grindstone, and an actuating means (24) for relatively moving the grindstone to an object (22) to be processed; thereby shaping and grinding the object and dressing the grindstone simultaneously,

   characterized in that

   said disc-like shaping tool is a disc-like shaping electrode (4) for shaping as a negative electrode and comprises an electrically conductive part and a semi-electrically conductive part.

2. An apparatus for profile mirror surface grinding according to claim 1, **characterized by** said electrically conductive grindstone (1) consisting of grains made of diamonds or CBN and an electrically conductive bonding part fixing the grains.

3. An apparatus for profile mirror surface grinding according to claim 1, **characterized by** said semi-electrically conductive part of the disc-like shaping electrode containing diamond grains.

Patentansprüche

1. Vorrichtung zum Hochglanz-Profilschleifen, die umfasst:

   eine Spannungsanlegeeinrichtung (9) mit einem elektrisch leitenden Schleifstein (1), der um seine Achse gedreht und als eine positive Elektrode eingesetzt wird, eine Abrichtelektrode (2) zum Abrichten als eine negative Elektrode, die der Oberfläche des Schleifsteins gegenüberliegend ohne Kontakt befestigt ist, sowie ein scheibenartiges Formwerkzeug (4), das um seine Achse gedreht wird und mit der Oberfläche des Schleifsteins in Kontakt kommt,

   Zuführeinrichtungen (10, 11, 12), die einem Raum zwischen dem Schleifstein und der Abrichtelektrode sowie dem Formwerkzeug ein elektrisch leitendes Schleiffluid zuführen,

   eine Bewegungseinrichtung (20), die das scheibenartige Formwerkzeug zusammen mit der Oberfläche des Schleifsteins bewegt, und eine Betätigungseinrichtung (24), die den Schleifstein relativ zu einem zu bearbeitenden Objekt (22) bewegt, um so das Objekt zu formen und zu schleifen und gleichzeitig den Schleifstein abzurichten,

   dadurch gekennzeichnet, dass:

   das scheibenartige Formwerkzeug eine scheibenartige Formelektrode (4) zum Formen als eine negative Elektrode ist und einen elektrisch leitenden Teil und einen elektrisch halbleitenden Teil umfasst.

2. Vorrichtung zum Hochglanz-Profilschleifen nach Anspruch 1, **dadurch gekennzeichnet, dass** der elektrisch leitende Schleifstein (1) aus Körnchen aus Diamant oder CBN und einem elektrisch leitenden Bindeteil besteht, der die Körnchen fixiert.

3. Vorrichtung zum Hochglanz-Profilschleifen nach Anspruch 1, **dadurch gekennzeichnet, dass** der elektrisch halbleitende Teil der scheibenartigen Formelektrode Diamantkömchen enthält.

Revendications

1. Appareil de meulage de surface miroir profilée comprenant :

   des moyens d'application d'une tension (9) ayant une meule conductrice électriquement (1) mise en rotation autour de son axe et utilisée en tant qu'électrode positive, une électrode de dressage (2) pour dresser en tant qu'électrode négative qui est fixée de manière opposée à la surface de la meule sans contact, et un outillage de mise en forme discoïdal (4) qui est mis en rotation autour de son axe et qui est mis en contact avec la surface de la meule,

   des moyens d'alimentation (10, 11, 12) pour fournir un fluide de meulage conducteur électriquement dans un espace entre la meule et l'électrode de dressage et l'outillage de mise en forme,

   des moyens de déplacement (20) pour déplacer l'outillage de mise en forme discoïdal le long de la surface de la meule, et des moyens de mise en action (24) pour déplacer de manière relative la meule par rapport à un objet (22) à traiter ; mettant en forme et meulant de ce fait l'objet et dressant la meule simultanément,

   caractérisé en ce que

   ledit outillage de mise en forme discoïdal est une électrode de mise en forme discoïdale (4) pour mettre en forme en tant qu'électrode négative et comprend une partie conductrice électriquement et une partie semi-conductrice électriquement.

2. Appareil de meulage de surface miroir profilée selon la revendication 1, **caractérisé en ce que** ladite meule conductrice électriquement (1) est constitué par des grains faits de diamants ou de CBN et par une partie de liaison conductrice électriquement qui fixe les grains.

3. Appareil de meulage de surface miroir profilée selon la revendication 1, **caractérisé en ce que** ladite partie semi-conductrice électriquement de l'électrode de mise en forme discoïdale contient des grains de diamant.

Fig. 1

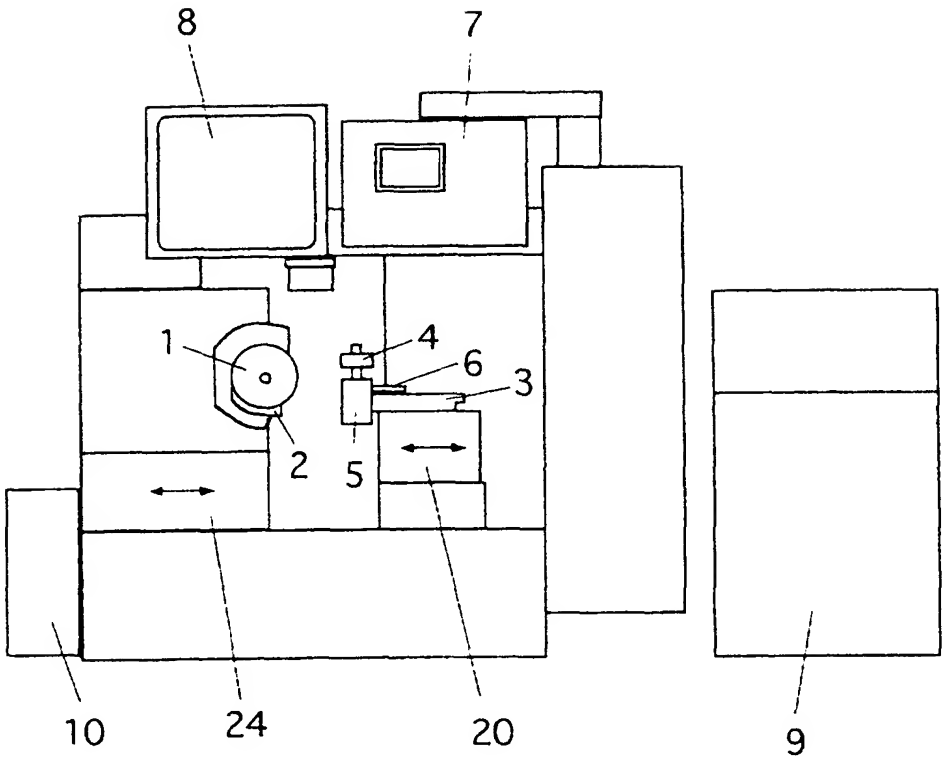

Fig. 2

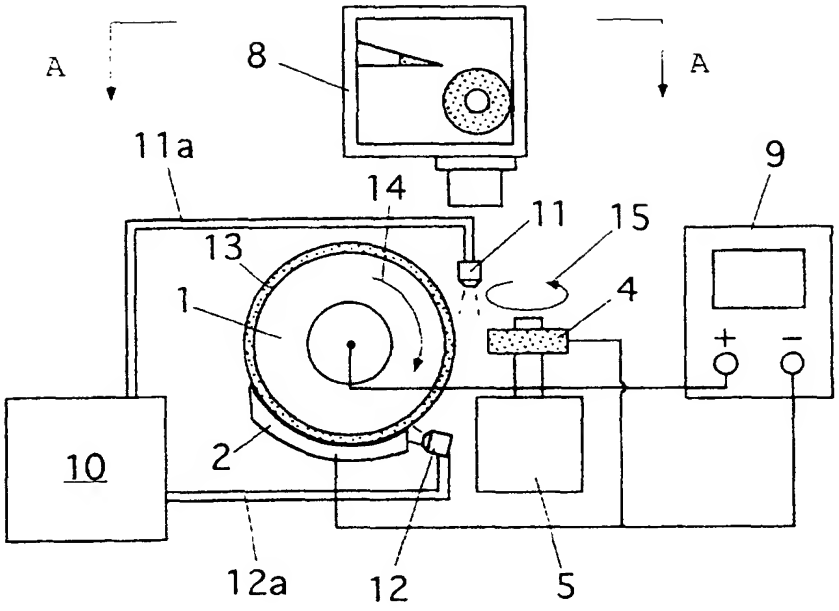

Fig. 3

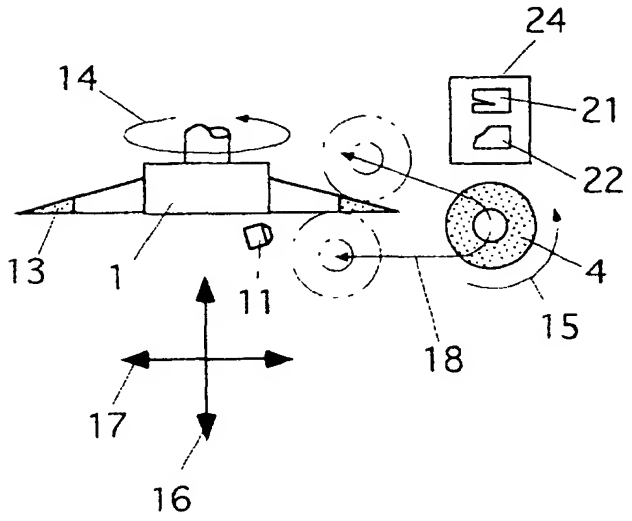

Fig. 4

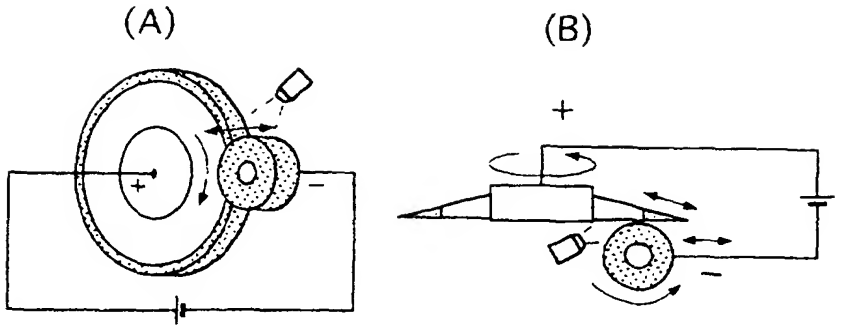

Fig. 5

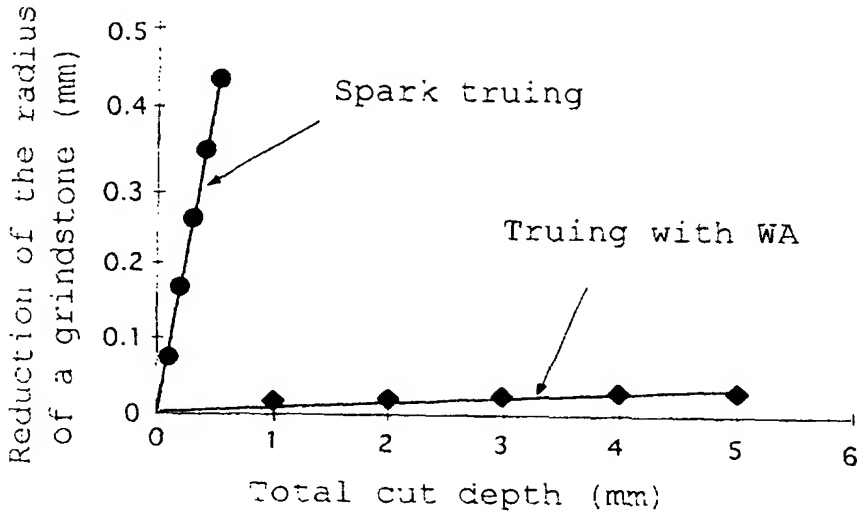

Fig.6